Hierarchical Assembly of Semiconductor Nanostrutures

Guiding Nature to Create New Semiconductor Structures at the Nanoscale

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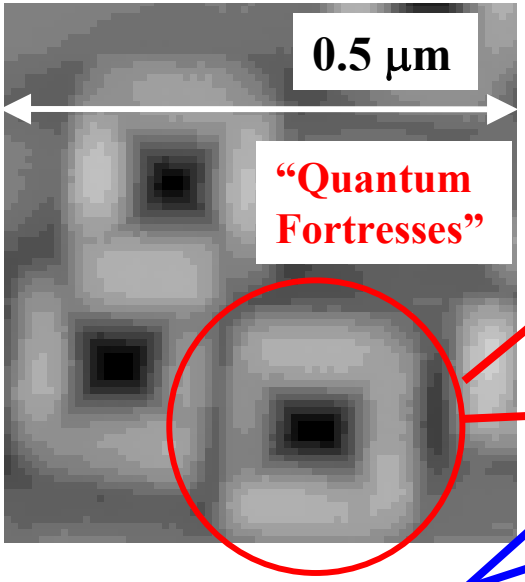
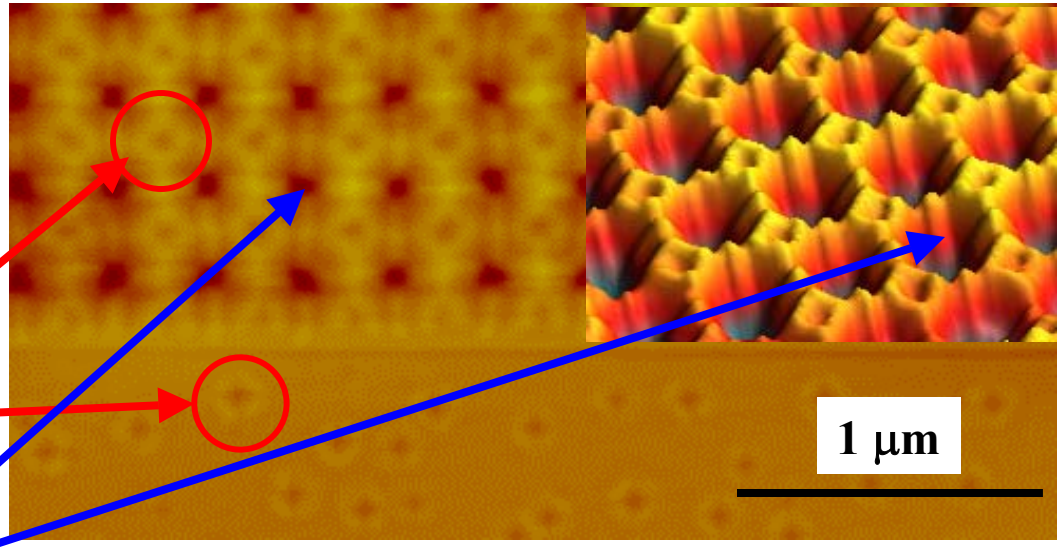
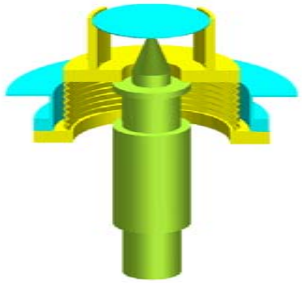




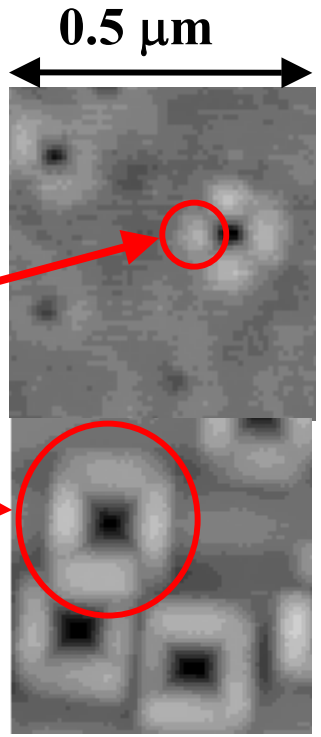
Focused Ion Beam – Created Pits



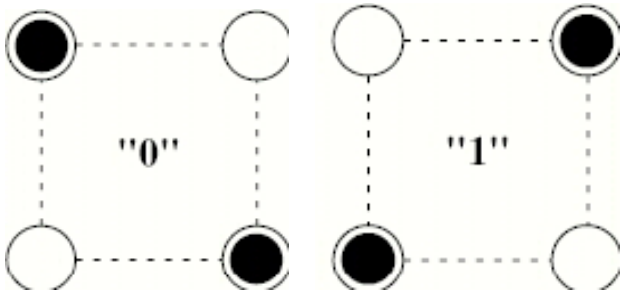
The positions of self-assembling GeSi/Si "Quantum Fortress" (QF) structures, previously discovered in this program, can be programmed using surface depressions created with a gallium focused ion beam: one QF forms at each interstice between holes. This provides a new method to achieve controlled nanostructure assembly.

Broader Impact

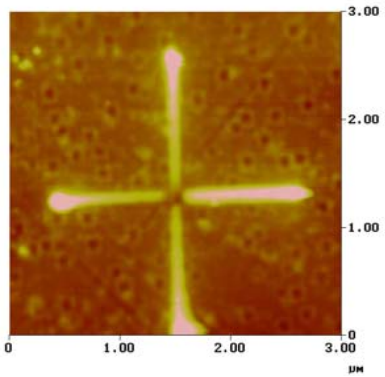
- **Hierarchical assembly: nanostructure control over multiple length scales – an emerging "Grand Challenge" in Nanomaterials.**
  - **Smallest length scale corresponds to individual components of the Quantum Molecule, c. 50 nm**
  - **Next length scale is that of mature quantum Fortress, c. 200 nm**
  - **Largest length scale is of FIB pattern controlling QF formation, - tens of microns, or even larger**



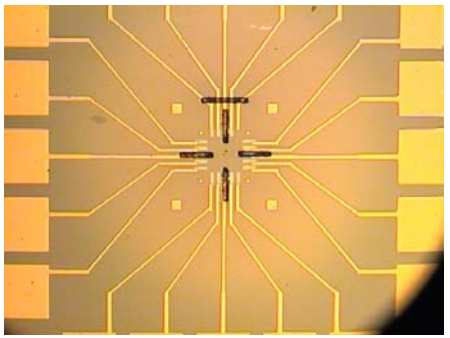
- **Potential applications to Quantum Cellular Automata Structures: a new nanoelectronic architecture (with Greg Snider, Notre Dame, under UVa MRSEC funding)**



Electronic charges in quadruplet clusters form bistable states due to charge repulsion, mimicing binary states of digital logic



Focused ion beam contacting to fortress elements



Combined electron beam and focused ion beam lithography to create the nanoelectronic circuit